Physics 311

Homework Set 6

1. A hollow spherical shell carries charge density

$$\rho(r) = kr^{\pi} \tag{1}$$

for some constant k in the region $a \leq r \leq b$ (Fig. 2.25). In Homework Set 5, you considered this charge density and computed the electric field in the three regions. Using this electric field in the three regions, calculate the potential at the center, using infinity as your reference point.

2. A long coaxial cable (Fig. 2.26) carries a *volume* charge density

$$\rho(s) = \rho_0 \frac{s}{a} \tag{2}$$

on the inner cylinder (radius a), and a *uniform surface* charge density on the outer cylindrical shell (radius b). This surface charge is negative and of just the right magnitude so that the cable as a whole is electrically neutral.
Find the potential difference between a point on the axis and a point on the outer cylinder. Note that it is not necessary to commit yourself to a particular reference point if you use Eq. 2.22.

3. Using Eqs. 2.27 and 2.30, find the potential at a distance z above the center of the charge distributions in Fig. 2.34. In each case, compute $\vec{E} = -\vec{\nabla} V$.

4. Find the potential on the axis of a uniformly charged solid cylinder, a distance z from the center. The length of the cylinder is L, its radius is R, and the charge density is ρ.
Use your result to calculate the electric field at this point.

5. Consider four point charges located at the corners of a square with charges and coordinates

$$q_1 = q \ \ @ \ \ x = y = 0 \qquad , \qquad q_2 = 2q \ \ @ \ \ x = \ell \ , \ y = 0$$
$$q_3 = -q \ \ @ \ \ x = y = \ell \qquad , \qquad q_4 = 3q \ \ @ \ \ x = 0 \ , \ y = \ell \tag{3}$$

a) How much work did it take to bring in charge q_1 from infinity and place it in it's corner?

b) How much work does it take to assemble the whole configuration of four charges?

6. Find the energy stored in a uniformly charged sphere of radius R and charge q.

Do it three ways:

a) Use Eq. 2.43.

b) Use Eq. 2.45. Don't forget to integrate over *all space*.

c) Use Eq. 2.44. Take a spherical volume of radius a. What happens as $a \to \infty$?